CALIFORNIA DIVISION OF MINES AND GEOLOGY

FAULT EVALUATION REPORT FER-111

February 1, 1981

1. Name of fault.

Maacama fault, (Ukiah and Willits segments).

2. Location of fault.

Mendocino County; Ukiah, Elledge Peak, and Willits NE 7.5-minute quadrangles (see Figure 1).

3. Reason for evaluation.

Part of a state-wide program to zone active faults (see Hart, 1980). Historic ground rupture has been reported (as creep) along fault traces within the quadrangles listed above. The remaining segments of the Maacama fault zone will be evaluated as part of the 10-year program during the 1981-82 project year.

4. List of references.

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Gealey, W.K., 1951, Geology of the Healdsburg quadrangle, California: California Division of Mines Bulletin 161, pp. 7-50.

Harding-Lawson Associates, 1977, Recently active breaks along the Talmage fault zone, Mendocino County, California, in Maacama fault study, Sonoma and Mendocino Counties, California: U.S. Army Engineer District, San Francisco, Corps of Engineers, Appendix CE-1.

Hart, E.W., 1980, Fault-rupture hazard zones in California: California Division of Mines and Geology Special Publication 42 (revised).

Herd, D.G., and E.J. Helley, 1977, Faults with Quaternary displacement, northwestern San Francisco Bay region, California: U.S. Geological Survey Miscellaneous Field Studies Map MF-818.

Huffman, M.E., and C.F. Armstrong, 1980, Geology for planning in Sonoma County: California Division of Mines and Geology Special Report 120.

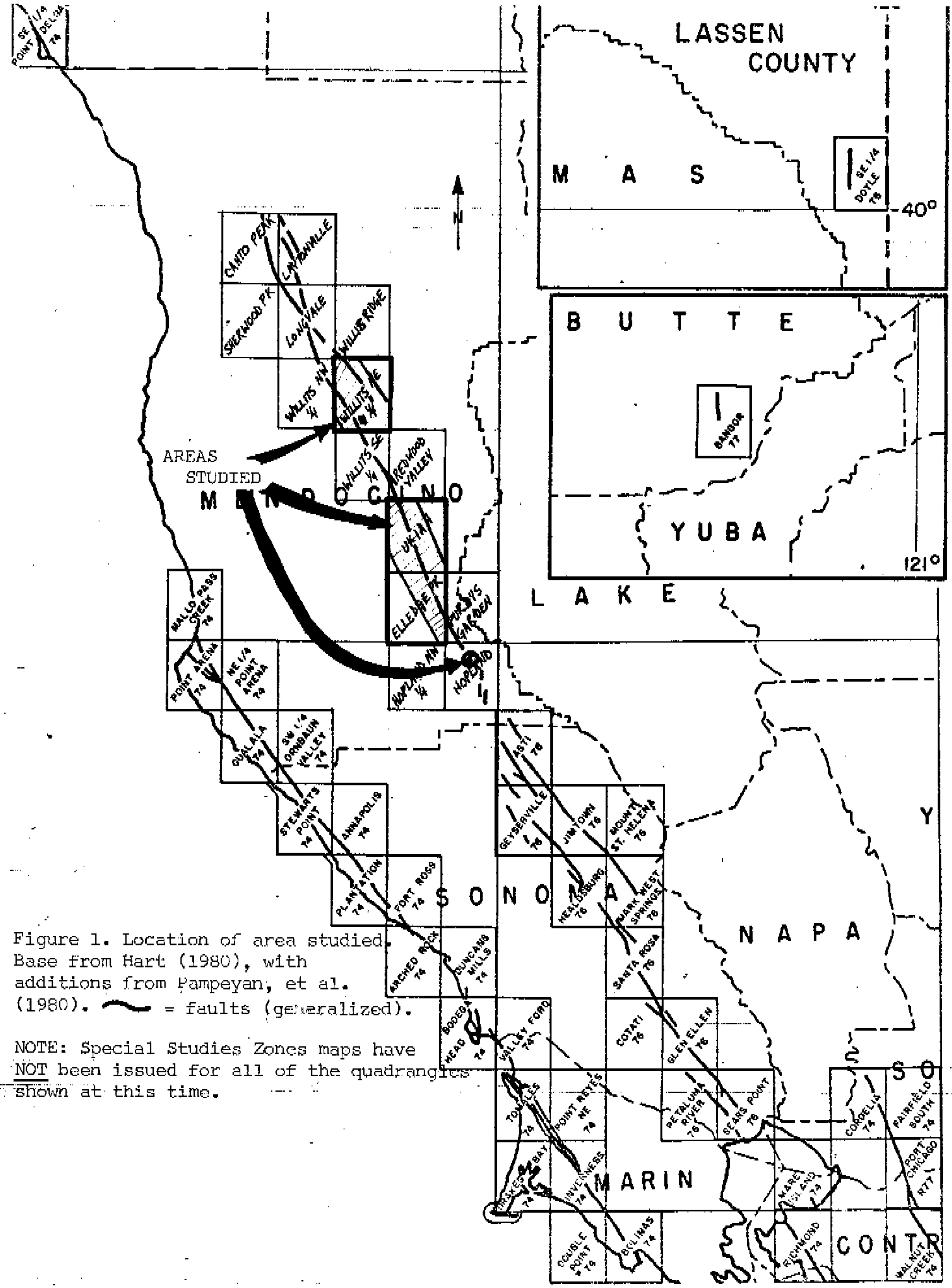

Figure 1. Location of area studied. Base from Hart (1980), with additions from Pampeyan, et al. (1980). = faults (generalized).

NOTE: Special Studies Zones maps have NOT been issued for all of the quadrangles shown at this time.

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National Aeronautics and Space Administration, 1972, U-2 Flight 72-119B, Infra-red (false color) aerial photographs (510-900nm spectral band), frames 1635-1641.

Pampeyan, E.H., P.W. Harsh, and J.W. Coakley, 1980, Preliminary map showing recently active breaks along the Maacama fault zone between Laytonville and Hopland, Mendocino County, California: U.S. Geological Survey Open-File Report 80-662.

Simon, R.B., E.H. Pampeyan, and C.W. Stover, 1978, The Willits, California, magnetude-4.8 earthquake of November 22, 1977: U.S. Geological Survey Open-File Report 78-1075.

U.S. Army Engineer District, San Francisco, Corps of Engineers, 1978, Maacama fault study, Sonoma and Mendocino Counties, California.

U.S. Department of Agriculture, 1963, Black and white aerial photographs, scale approximately 1:24,000, Flight CVN, 1DD #69 to 72, 105 to 110; 3DD #13 to 16, 23 to 28; and, 4DD #69 to 78.

Upp, R.R., 1980, Map of the Maacama fault zone (preliminary), in Holocene activity on the Maacama fault: Stanford University, PhD thesis, work in progress, map filed with CDMG (in San Francisco District Office).

5. Summary of available data.

As noted above, the scope of this report is generally limited to those segments of the Maacama fault zone along which historic fault rupture has been reported. Five such sites are evaluated herein:

A. Along State Highway 175, east of Hopland on the western edge of McDowell Valley (Hopland quadrangle), reported by Pampeyan, et al. (1980);

B. East of Ukiah in the area of Talmage (Ukiah quadrangle, immediately adjacent to the Elledge Peak quadrangle), reported by Upp (1980) and Pampeyan, et al. (1980);

C. North of Ukiah on Lake Mendocino Avenue about 4000 feet west of Coyote Dam (Ukiah quadrangle), reported by Upp (1980) and Pampeyan, et al. (1980);

D. In downtown Willits, reported by Upp (1980), Pampeyan, et al.(1980), and Kilbourne (1979); and,

E. On Hearst Road, at the western margin of Rocktree Valley, reported by Pampeyan, et al. (1980).

For the purposes of this study, traces associated with or located near those along which valid evidence of fault creep exists are fully evaluated herein. All other traces within the Maacama fault zone will be evaluated during project year 1981-82.

Pampeyan, et al. (1980) and Upp (p.c.) report that the Maacama consists of a zone of Holocene, right-lateral faults. Downslope movement of unstable terrain has produced topographic features sometimes confused with fault-produced topography, while obliterating some features actually created as the result of fault movement.

Early work along the Maacama zone was generally directed at other than geologic hazards detection. Even so, Gealey (1951, p.32), who named the Maacama fault zone, cited features such as sag ponds, perched alluvium, aligned drainages, and beheaded drainages as evidence of recent movement along the Maacama and Healdsburg fault zones in the Healdsburg 15-minute quadrangle. Similarly, Cardwell (1965, p.22) states that "Recent" (Holocene) fault movement has occurred in several locations in the Ukiah Valley area; however, none of his maps show any faults near Ukiah. McNitt (1968) was unable to document Quaternary faulting along either the Maacama fault or any other fault within the Kelseyville 15-minute quadrangle. However, he cites the historic seismicity as an indication that fault activity may be continuing within the area he studied.

According to Pampeyan, et al.(1980), in 1955 the U.S. Army Corps of Engineers released a report which documented that the Maacama fault zone extended northward to Hopland. Huffman and Armstrong (1980), in a report released to Sonoma County in 1974, documented late Quaternary movement along the Maacama. They also stated that Radbruch-Hall had verbally reported two apparently offset fences just south of Big Sulphur Creek (not evaluated in this study) along the Maacama. Herd and Helley (1977) classified the Maacama as Pleistocene (last movement 10,000 to 2,000,000 years ago) in age, even though reporting that features (sag ponds, linear troughs, etc.) generally regarded as evidence of Holocene activity, existed along the fault in their study area.

In November, 1977, a 4.8-M(local) earthquake occurred near Willits, causing a moderate amount of damage. According to Simon, et al. (1978), J.M. Coakly observed cracked pavements in the downtown Willits area in the course of monitoring aftershocks. Pampeyan and Harsh were dispatched on December 14, and noted en echelon cracks in pavement and right-laterally displaced curbs and sidewalks in five locations. Simon, et al., further state that most of these features predate the November 22 earthquake, "but at least a small amount of creep occurred between November 23 and December 14." They further state that creep rates appear to be on the order of 2 mm per year. They also tend to discount the possibility that the November 22 event was caused by movement along the creeping trace since UC Berkeley determined that the epicenter was approximately 9 miles east of Willits. The existence of features indicative of fault creep in Willits was confirmed by Kilbourne (1979), Pampeyan, et al.(1980), and Upp (1980).

In January, 1978, the U.S. Army Corps of Engineers released a study of the Maacama fault. Within the Corp's report were several other, earlier reports. Harding-Lawson Associates (1977), for example, primarily relied on aerial photo interpretation, literature research, and limited field reconnaissance in the completion of their study. They documented the existence of a clay gouge zone in older alluvium along the fault zone north of Ukiah. However, the primary objective of the Corp's study, and the Harding-Lawson study, was to determine the overall length of the active Maacama fault so that the maximum credible earthquake could be estimated. Those fault traces identified by Harding-Lawson Associates and studied in this report are plotted on Figures 2A, 2B, and 2C.

Upp (1980) and Pampeyan, et al. (1980) conducted studies along the Maacama fault almost simultaneously. However, the products of each are quite different. Pampeyan, et al., primarily interpreted aerial photographs and conducted limited reconnaissance field mapping. The stated purpose of their map was to "...show the recently recognized sites of tectonic creep and their relation to lineaments and features interpreted to be the result of recent (Holocene) movements within the Maacama fault zone." Unlike other U.S.G.S strip maps, Pampeyan, et al., indicate they did not annotate all of the features (sag ponds, etc.) visible along the faults depicted. Indeed, many of the faults they show have no annotations whatever. And, in describing some of the traces they depict, they indicate that post-Pleistocene movement may not have occurred. Their legend indicates that they interpret all features depicted as being recently active faults, varying only as to the level of certainty of Holocene movement.

In contrast, Upp (1980) depicts a fairly narrow zone of Holocene faults, carefully annotating all of the features he detected. His work is the product of air photo interpretation and a much more intensive field survey that conducted by Pampeyan, et al. On the preliminary map given to CDMG, Upp highlighted in red those traces he believes are unequivocably Holocene in age. However, he stated (p.c.) that all the faults shown on his map are probably Holocene, only that he lacks overwhelming proof of Holocene activity on some traces. Faults of Upp and Pampeyan, et al., are shown on Figures 2A, 2B, and 2C, with annotations summarized.

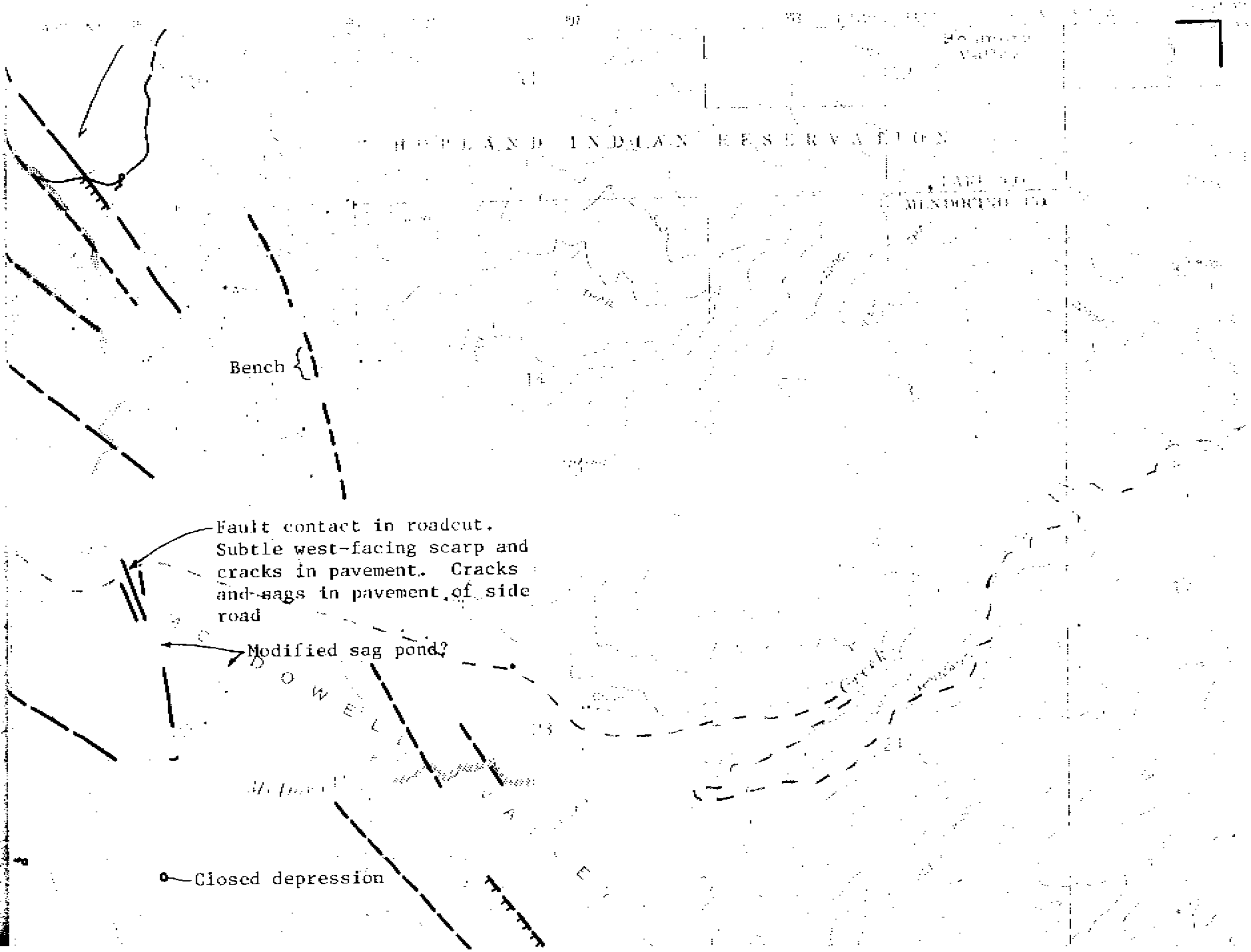
6. Validity of fault creep data.

Site A: Highway 175 east of Hopland (see Figure 3).

Pampeyan, et al.(1980), imply, but do not directly state, that the features at site A may be the result of fault creep. In addition to the annotations on the map (Figure 3), their text (p. 16) indicates the cracks referred to are aligned with the subtle, west-facing scarp and a fault exposed in a roadcut.

On January 14, 1981, I visited the site. No cracks could be detected in the pavement of State Highway 175. The roadcut had sufficiently failed that no fault was clearly exposed; however, it may be that a fault exists beneath the collapsed materials. Cracks and sags were present in the pavement of the unnamed sideroad. However, the trend of the en echelon cracks, as well as the sags, and the predominant trend of all the cracks observed, was slightly curvilinear and perpendicular to the trend of the fault depicted in Figure 3. Numerous right-stepping fractures, parallel to the road, were observed, and the slope below the road was steep and planar suggesting the road was partly built on fill. No fractures consistant with right-lateral fault creep on the fault depicted could be found. Thus, it appears (90% confidence level) that these cracks are due to subsidence (or a minor slope failure) and not fault creep. Further evaluation of the features in this area is, therefore, deferred until the 1981-

Figure 3.


HOPLAND INDIAN RESERVATION
Bench
Fault contact in roadcut. Subtle west-facing scarp and cracks in pavement. Cracks and sags in pavement of side road
Modified sag pond?
Closed depression

82 project year.

Site B: East of Ukiah in the area of Talmage (see Figure 2B).

Both Upp (1980) and Pampeyan, et al. (1980), have reported fault creep at the same locations near Talmage. Upp's field notes are not yet available for these sites. Pampeyan, et al., report three locations where well-defined sets of en echelon cracks, aligned with fault-produced topography, cross roads (see Figure 2C).

On January 14, 1981, I visited these sites. At the southernmost site, on River Road, cracked pavement was clearly visible (localities U-7, U-8, Fig. 4B, Table 1). Both right-stepping and left-stepping fractures were observed, but the fractures at the northern end of this site were primarily left-stepping, on trend with the adjacent fault scarp. This zone of cracks is aligned with an offset fence (Hart, p.c.). Immediately to the north, cracks were present across Mill Creek Road, but these cracks were continuous -- not en echelon.

The central of Pampeyan, et al's, sites is located on the extension of the City of Ten Buddhas' property (locality U-6). Here some small, left-stepping fractures were visible in the pavement, adjacent to a much larger crack. Curbs at either end of the cracked zone were broken and possibly extended, but not clearly offset.

Further north, between Pampeyan, et als', northern and central Talmage sites (locality U-5), minor cracks were observed in the pavement of River Road on trend with a fault scarp. Hart (p.c.) reported a left-stepping pattern was observed.

The northernmost Talmage site (locality U-4) lies just north of and on trend with a well-defined fault scarp. Here eight left-stepping frac-

Photo 1. Sanford Ranch Road just south of Regina Heights showing left-stepping, en echelon factures (northern creep site of Pampeyan, et al (1980) in the Talmage area). Looking north.

Photo 2. Another view of the site shown in Photo 1, showing the left-stepping pattern.

<u>TABLE 1.</u> Description of evidence for fault creep along the Maacama fault.

<u>Ukiah quadrangle</u> (see Figure 4B)

U-1. On Lake Mendocino Avenue about 400 feet west of Coyote Dam there is a zone of left-stepping, en echelon fractures in the pavement adjacent to and on trend with a west-facing fault scarp. A slight but abrupt rise in the roadway coincides with the fractures zone, west side up (A-quality*) (see Photo 3).

U-2. On Redemeyer Road approximately 2300 feet north of El Dorado there is a zone of buckled and cracked pavement adjacent to a fault mapped by Pampeyan, et al. (1980) (C-quality) (see Photo 7).

U-3. On Redemeyer Road just north of El Dorado there is a long zone of left-stepping, en echelon fractures. Adjacent to some of the left-stepping fractures is a series of low compression rolls in old pavement. Three left-stepping fractures were present in a newly paved section of road immediately north of El Dorado. All of these features occur in a single, narrow zone less than 2 feet wide, with, occassionally, long continuous fractures (see Photos 4 through 6) (B-quality).

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* The quality ratings consider the level of certainty, type and magnitude (relative to background "noise") of the fault creep data. "A" quality sites are those where virtually all man-made features show the effects of fault creep, and two or more types of evidence (e.g., offset curbs and left-stepping en echelon fractures in pavement) support fault creep. "B" quality sites are those where one or more of the above factors is absent. For example, a site where one curb is offset, some en echelon fractures are observed, but the other curb is not offset would be a "B" quality site. "C" quality sites are those where only one line of evidence is present. For example, a locality having one offset curb (if the offset is significantly larger than the background "noise") would be a "C" quality site.

U-4. A narrow zone of 8 left-stepping, en echelon cracks across Sanford Ranch Road on trend with a fault scarp (to the south), additional zones of cracked pavement, and an offset fence. (A quality) (see Photos 1 and 2).

U-5. A zone of minor cracks cross Sanford Ranch Road, trending NNE, adjacent to a fault scarp. Centerline of road is offset. On trend with NE-facing scarp. (A quality).

U-6. On the City of Ten Buddhas property, a wide crack is present in the pavement of the entrance road. Some small left-stepping, en echelon fractures are present adjacent to the larger crack. Curbs not visibly offset, but cracked and extended slightly (B-quality).

U-7. Linear, narrow zone of cracked pavement (on road fill) across Mill Creek Road on trend with the other features described (U-5 & U-8) (C quality). Aligns with U-8.

U-8. Zone of cracked pavement on East Side Road. On the south end most fractures are parallel to the roadway, both right and left-stepping. On the north end the zone is primarily left-stepping, about 30° off the trend of the road. One order only. Southernmost fractures probably due to settlement of roadway. One fence is offset, and the zone is along an E-facing scarp (A quality).

Willits quadrangle

W-1. Zone of left-stepping and continuous cracks in pavement trending toward #61. (C quality).

W-2. Bridge across Mill Creek appears to be rotated clockwise; 2 orders of left-stepping, en echelon fractures in pavement between bridge and church to north (B+ quality).

W-3. South sidewalk and curb of W. Commercial are right-laterally offset (no north curb present), on trend with NW-trending zone of left-stepping fractures in AC pavement (A-quality) (see Photos 10 and 11).

W-4. The north curb of W. Mendocino is extrended and bent (right-laterally) slightly (C quality).

W-5. Zone of crudely left-stepping fractures in street (C+quality).

W-6. Long, narrow zone of left-stepping, en echelon fractures in pavement of road in Grange Mobile Home Park. Chain link fence is offset 3" to 4", and one mobile home and swimming pool are deformed and cracked (Hart,p.c.) (A quality).

W-7. Narrow zone of left-stepping, en echelon cracks across West Valley at McKinley. Both curbs and sidewalks are clearly right-laterally offset (see Photos 8 and9) (A-quality).

W-8. Two extended and right-laterally offset curbs; street patched in this area, only one crack visible between the offset curbs (B-quality).

Photo 3. Left-stepping,,en echelon fractures in the pavement of Lake Mendocino Drive, looking north.

Photo 4. Left-stepping cracks in Redemeyer Road just north of El Dorado. Looking south.

Photo 5. Left-stepping cracks in Redemeyer Road. Location is a few feet south of Photo 4. Looking south.

Photo 6. Redemeyer Road, just south of Photo 5, showing some left- stepping cracks trending into a long, continuous crack, looking south.

Photo 7. Redemeyer Road, several hundred feet north of the site where Photos "4 - 6" were taken, showing cracks in pavement and subtle bulge. Looking south.

FER III

Photo 8. The south curb of West Valley at McKinley (Willits) is right-lateraliy offset. En echelon fractures are visible in the pavement trending toward the offset curb (Photo 9, below).

Photo 9. Looking south toward the offset curb shown in Photo 8.

Photo 10. Left-stepping, en echelon fractures in the street in front of 154 w. Commercial, Willits (looking north).

reversed

Photo 11. Right-laterally offset curb across the street from 154 W. Commercial, on trend with the fractures shown in Photo 10.

tures were clearly visible in a narrow zone crossing the roadway (see Photos 1 and 2). Pampeyan, et al., report that they have measured creep at a rate of 1 mm per year at this location.

Thus, it is certain that fault creep has occurred in the Talmage area.

Site C: Lake Mendocino Avenue.

Both Pampeyan, et al. (1980) and Upp (1980) have reported en echelon fractures in the pavement of Lake Mendocino Avenue west of Coyote Dam. These fractures lie on trend with and at the southern end of a west-facing scarp (Fig. 28).

On January 14, 1981, I verified the existance of the reported fractures. Not only were left-stepping fractures apparent, but so was a slight rise in the roadway, east side up, consistant with the adjacent escarpment (see Photo 3) / Between sites B and C (Figure 4B, Table 1, Loc. ~~V~~U-1).

An attempt was made to detect evidence of fault creep between sites B and C, heretofore unrecognized. A zone of fractures was observed in the payment of Redemeyer Road a few hundred feet north of El Dorado Road, (Loc. ~~V~~U-3). In general, the fractures were parallel to the roadway, which parallels the hillfront in this area. Fractures were often continuous, but several left-stepping, en echelon fractures were observed (see Photos 4,5, and 6). Also noted, adjacent to several of the en echelon fractures, were slight buckles in the pavement. About 1000 feet to the north, (locality ~~V~~U-2) more fractures having approximately the same trend, were noted along a fault mapped by Pampeyan, et al. (Photo 7). While not conclusive, it is possible that these fractures are the product of fault creep (50% certainty), especially since they are approximately on trend with those observed at sites C and B.

Site D: Downtown Willits.

As noted earlier, fault creep evidence in Willits has been reported by

Simon, et al. (1978), Kilbourne (1979), Upp (1980), and Pampeyan, et al. (1980). On January 15, 1981, I verified that fault creep has occurred in the area. Left-stepping, en echelon fractures on trend with offset curbs and sidewalks were noted in several locations (see Photos 8, 9, 10, and 11 for representative samples). These sites are further described in Table 1 (see also Figure 2A and 4A).

Site E: Hearst Road at west margin of Rocktree Valley.

Pampeyan, et al. (1980, p.13) report en echelon cracks were observed in the pavement of Hearst Road (they incorrectly refer to it as Hearst-Willits Road) where it crosses the Rocktree Valley fault. On January 15, 1981, I visited the site. Hearst Road is only partially paved. The paved section at the site is very short. The adjacent roadcut has exposed a zone of typical Franciscan melange in which no distinct fault plane was visible. Cracks in the pavement were primarily parallel to the roadway and the free face of the slope below. A few additional, randomly oriented cracks were also observed. However, it is most likely that settlement of the roadway is the cause ~~for~~ of the en echelon fractures, which trend about perpendicular to the fault delineated by Pampeyan, et al. Further evaluation is therefore deferred until the 1981-82 project year.

A rapid reconnaissance was made near the features noted in this section (section 6). Except for the features described here and in Table 1, no additional evidence of fault creep was found.

7. Air photo interpretation.

U.S. Department of Agrilculture (1963) air photos were interpreted and the fault related features carefully plotted using a stereoplotter (see Figures 4A, 4B, and 4C). Some areas along the fault zone are obscurred or complicated due to the sheared nature of the Franciscan terrain and the presence of large landslides. Even so, the topographic features were distinct enough to demonstrate that Holocene activity probably occurred along a fairly well-defined faults.

It was apparent from high-altitude photos (NASA, 1972) that the Eel and Russian Rivers have downcut tremendously into the terrain. The floors of small alluvial valleys, such as Rocktree Valley (Willits quadrangle) are elevated 1500 feet or more above the present Eel and Russian River flood plains. Such high valleys are found both east and west of the main Eel and Russian River basins. Thus, though some persons may think, at first, that these valleys have been uplifted along faults bordering the Eeland Russian basins, this is not necessarily the case.

The riverene processes have left their marks on the land, as well. Remnants of river terraces are present in several areas, often having an abrupt, linear edge. However, small drainages on trend with the terrace edges are frequently not deflected (see Figure 4C for an example). Similarly, small depressions and tonal contrasts are visible in the flood plains; however, these features are usually short and confined to a single geologic unit (e.g., recent alluvium). Thus, they are most likely the result of scouring by streams and different depositional events. Many such features have been plotted as faults by Pampeyan, et al. (1980), and a few have been depicted by Upp (1980).

Because of the limited scope of this investigation, and the limited amount of time available during this project year, I have not plotted and individually analyzed most of these apparently non-tectonic features. Instead, this additional work is deferred to the 1981-82 project year. My approach has been to independently interpret the photos. I have plotted only those features suggestive of recent faulting (see Figures 4A, 4B, and 4C).

8. Seismicity.

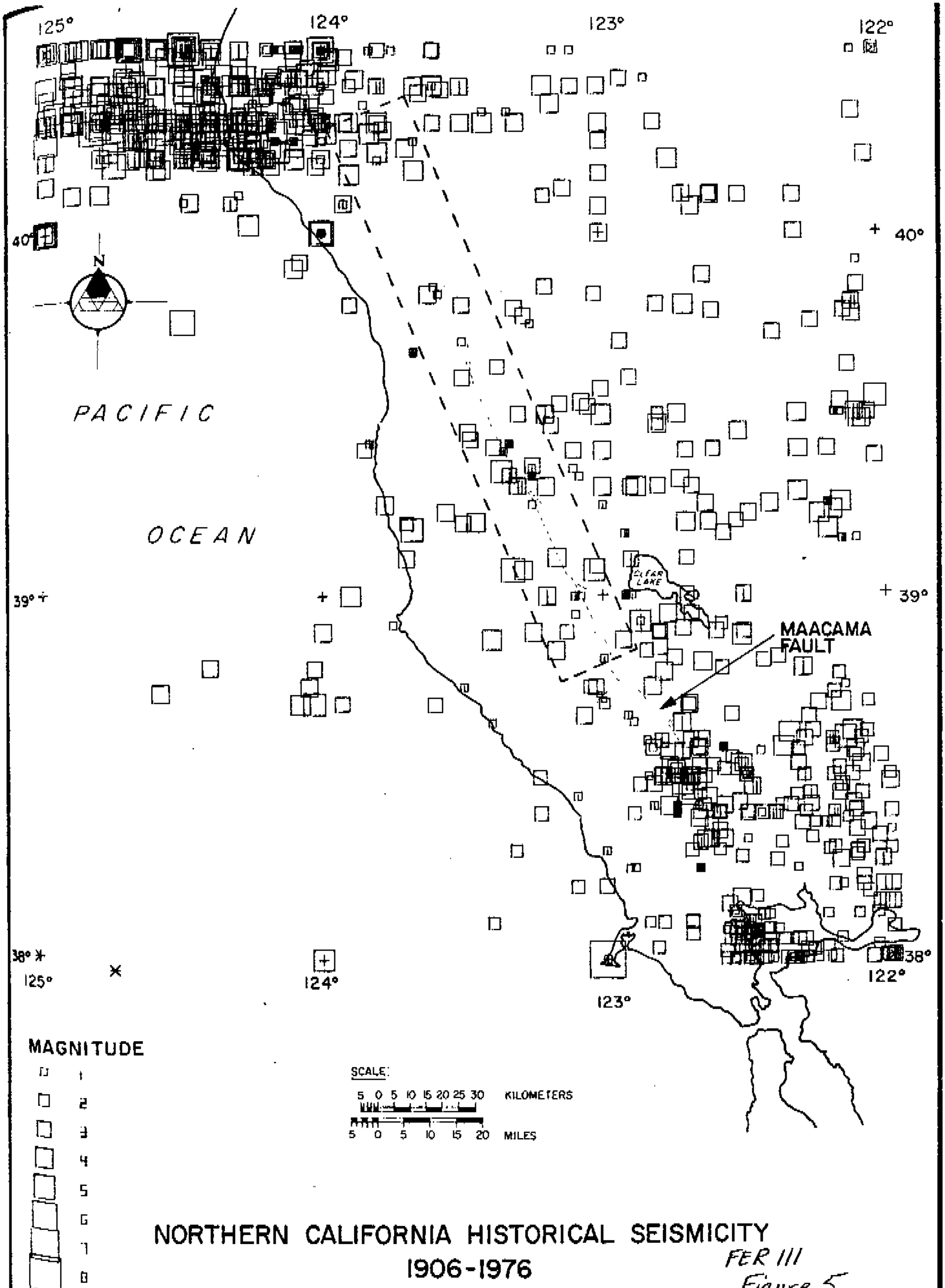
Dames and Moore (1977) conducted an intensive study of the seismicity along the Maacama fault. They report that relatively complete records and locations of earthquakes greater than M 2.5 are only available for the period since about 1962. They state that the apparent lack of recorded earthquakes less than M 3.5 north of Willits is probably related more to the detection capabilities of the U.S.G.S. abd U.C. seismic networks than to seismotectonics.

The Dames and Moore (1977) study was directed at detecting microearthquakes along the Maacama fault zone. While the seismographic record from 1906 to 1976 does not clearly show a zone of greater seismic activity along the Maacama (see Figure 5), the microseismic survey conducted over a 72-day period ending September 23, 1977, does appear to document seismic activity associated with the Maacama fault. The activity extends along the fault as mapped by Harding-Lawson Associates (1977), and northward about 10 km beyond their northernmost trace. Dames and Moore also noted that the microseismicity seemed to lie slightly east of the mapped trace, and that solutions were consistant with right-lateral, strike-slip movement (see Figures 6 and 7).

As noted earlier (see section 5), a 4.8 earthquake occurred near Willits in November , 1977, just after the Dames and Moore study concluded. Simon, et al. (1978) suggested, based on UC Berkeley data, that this epicenter was located about 9 miles east of the Maacama fault.

9. Conclusions.

The Dames and Moore (1977) data strongly suggest that the Maacama fault is seismically active. That most of the epicenters lie east of the fault can be explained if the fault dips eastward, or if the crustal model used



NORTHERN CALIFORNIA HISTORICAL SEISMICITY
1906-1976

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Figure 5.

REFERENCE:
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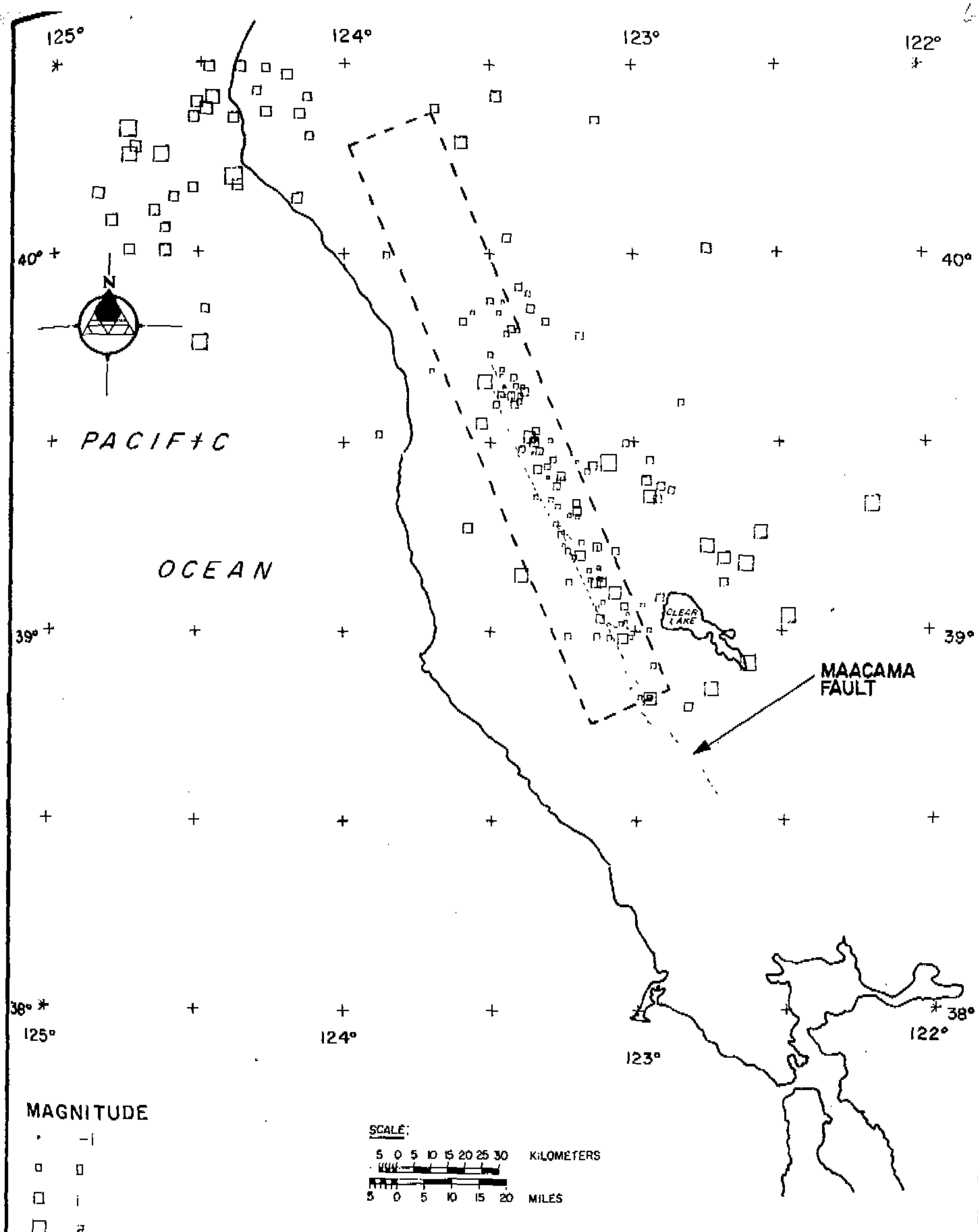
p. 21

DAMES & MOORE

APPENDIX CE-3

PLATE 6



EPICENTRAL MAP-ALL LOCATABLE EVENTS
EXCLUDING FIXED AND BACKGROUND NETWORK EVENTS

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Figure 6

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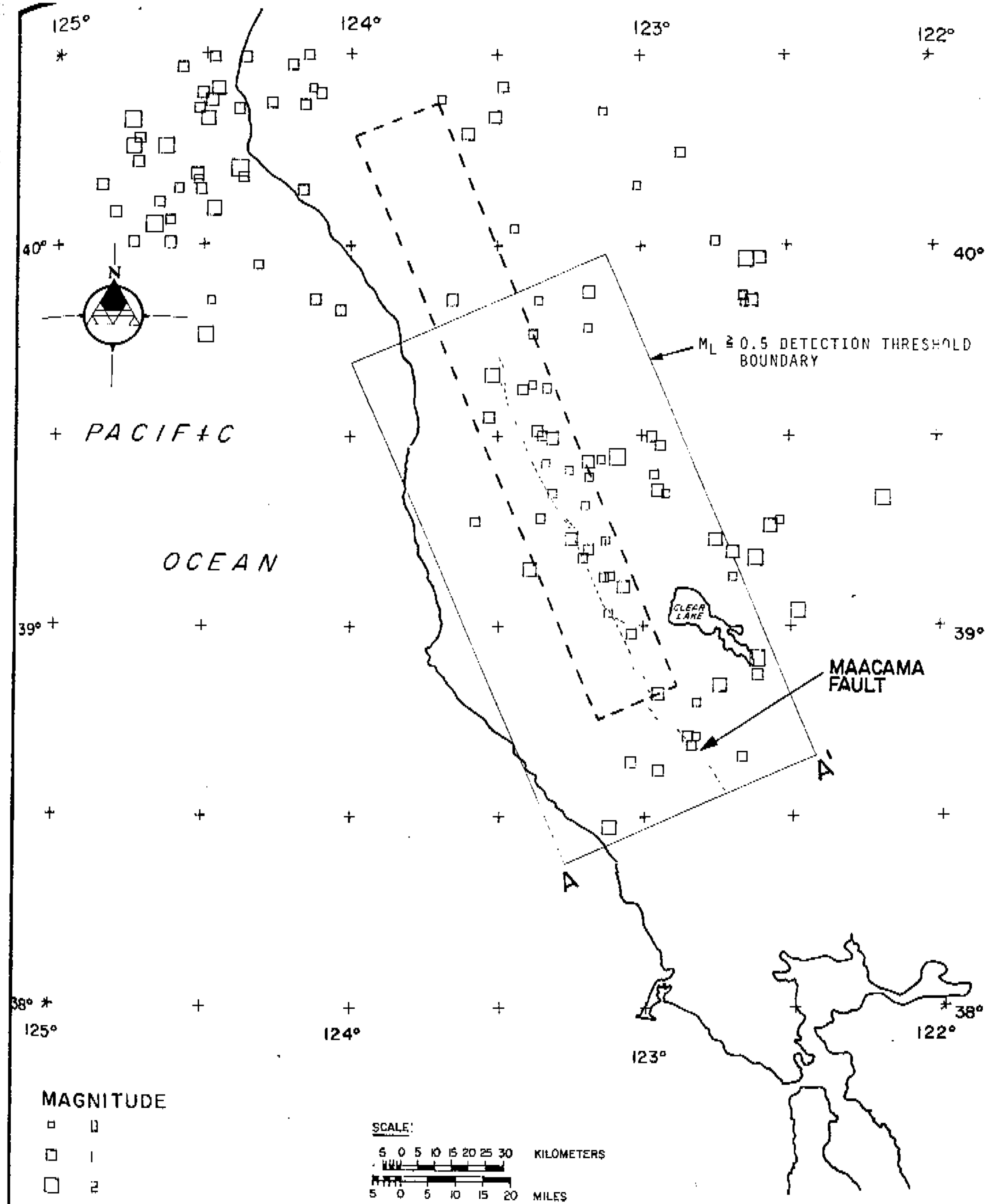
DAMES & MOORE

APPENDIX CE-3

PLATE 12



EPICENTRAL MAP - ALL LOCATABLE EVENTS WITH $M_L \geq 0.5$

FER III
Figure 7

NOTE:
REFER TO PLATE 18 FOR CROSS SECTION A-A'

p. 23

DAMES & MOORE

by the seismologists is slightly in error. Similarly, the location of the November, 1977, event 9 miles east of the fault should not be regarded as absolute; few seismographs are located near enough to the epicentral area to be able to accurately locate the epicenter.

The fault creep evidence observed in Willits and near Ukiah is quite convincing, certainly as good as similar evidence along the Hayward fault to the south. Geomorphic evidence, though obscurred partly or wholly in places by erosional features, also strongly indicates the existence of a Holocene fault along the trend mapped. These faults are reasonably well-defined in the area studied.

With respect to the differences in the maps of Upp (1980), Pampeyan, et al. (1980), and Harding-Lawson Associates (1977), it appears the work of Upp is more consistent and reproducible by other workers than are the other two. In part this is due to the apparent intent of the various workers. Harding-Lawson Associates clearly state they were concerned with determining the overall length of the Maacama fault zone. It appears their work was limited to identifying selected, young geomorphic features indicative of recent faulting, and that they tended to connect the features with straight lines. Work by Upp, Pampeyan, et al., and myself suggests that ~~straight lines~~ these faults are really not as straight or as continuous as Harding-Lawson Associates indicate, ~~lacking~~ and that they omitted much of the detail visible on the air photos and in the field.

Pampeyan, et al. (1980), appear to have tried to identify <u>any</u> feature that could <u>conceivably</u> have been produced by recent (Holocene) faulting. I have concluded, based on my own air photo interpretation and supported by the work of Upp, that many of the features shown by Pampeyan, et al., are probably not the result of recent faulting, and that several are probably not the through-going, simple faults they depict, if they are indeed faults at all.

My own interpretations and field observations, limited though they may be, closely parallel those of Upp (1980ms). Since Upp's map is the result of both air photo interpretation and intensive field mapping directed at detecting Holocene faults, I believe his maps should be the primary reference used in delineating the faults to be shown.

10. Recommendations.

All of the traces shown in red by Upp (his definitely Holocene traces; 1980) should be zoned, (Figure 2A, 2B, and 2C), supplemented by additional traces he mapped which I believe are probably Holocene. And, in a few instances, features depicted by Smith (this report) should be shown as well. These faults are delineated, along with the recommended Special Studies Zones boundaries, on Figures 8A, 8B, 8C.

11. Investigator; date.

Theodore C. Smith

Theodore C. Smith
Associate Geologist
RG 3445, CEG 1029
February 1, 1981

TCS/jab

I agree with recommendations.
EWH
4/9/81

FER III
Figure 8A. Recommended Special Studies Zones

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Figure 8C. Recommended Special Studies Zones.